



# **STIC Search Report**

## **EIC 1700**

**STIC Database Tracking Number: 162535**

**TO: Mahomoud Dahimene**

**Location: REM 9A70**

**Art Unit : 1765**

**September 9, 2005**

**Case Serial Number: 10/730234**

**From: Kathleen Fuller**

**Location: EIC 1700**

**REMSSEN 4B28**

**Phone: 571/272-2505**

**Kathleen.Fuller@uspto.gov**

### **Search Notes**

I only found found the applicant with both the pull back and second mask concept. I searched many files including the EP full text patent file.

*pg Pub 2004 0266076*



**Smith, Teresa (ASRC)**

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**From:** Unknown@Unknown.com  
**Sent:** Monday, August 15, 2005 10:29 AM  
**To:** STIC-EIC1700  
**Subject:** Generic form response

ResponseHeader=Commercial Database Search Request

AccessDB#=

162535

LogNumber=

Searcher=

SearcherPhone=

SearcherBranch=

MyDate=Mon Aug 15 10:29:01 EDT 2005

submitto=STIC-EIC1700@uspto.gov

Name=Mahmoud Dahimene

Empno=81440

Phone=22410

Artunit=1765

Office=REM 9A70

Serialnum=10730234

PatClass=216/011.000

Earliest=12/09/2003

Format3=email

Searchtopic=The application I am examining relates to a method of forming Fins for "FinFET" transistors. The method uses a hard mask pull-back method to get around the photolithography limitations for features smaller than 50 nanometers. The two key features the applicant uses are "hard mask pull-back" and "second hard mask". I could find references for each feature separately. I need a reference that combines both features, or both features separately related to the formation of "FinFET" transistor fabrication. The mask "pull-back" method is well know, by itself, for trench corner rounding, or adjustments of masks in lithography. However, no reference combines mask pull-back and deposition and etch of a second hard mask to allow the fabrication of features substantially smaller than the present lithography limits would allow.

The key-words/expressions are: FinFET ; Fins ; hard mask pull-back (or mask pull-back) ; second hard mask ; Etching ; 50 nanometers and smaller features ; silicon ; oxide.

Comments=If you have questions please call 22410.  
I am usually at my desk between 7:30 AM. and 4:00 PM

send=SEND

SCIENTIFIC REFERENCE BR  
Sci & Tech Inf - Cnt

AUG 12 RECD

Pat. & T.M. Office



# STIC Search Results Feedback Form

**EIC17000**

Questions about the scope or the results of the search? Contact *the EIC searcher* or contact:

Kathleen Fuller, EIC 1700 Team Leader  
571/272-2505 REMSEN 4B28

## Voluntary Results Feedback Form

- I am an examiner in Workgroup:  Example: 1713
- Relevant prior art **found**, search results used as follows:

- ☐ 102 rejection
- ☐ 103 rejection
- ☐ Cited as being of interest.
- ☐ Helped examiner better understand the invention.
- ☐ Helped examiner better understand the state of the art in their technology.

Types of relevant prior art found:

- ☐ Foreign Patent(s)
- ☐ Non-Patent Literature  
(journal articles, conference proceedings, new product announcements etc.)

- Relevant prior art **not found**:

- ☐ Results verified the lack of relevant prior art (helped determine patentability).
- ☐ Results were not useful in determining patentability or understanding the invention.

Comments:

=> FILE HCAPL

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FILE LAST UPDATED: 8 Sep 2005 (20050908/ED)

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=> D QUE L15

L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#  
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)  
L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR  
PULLBACK?)  
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L10 1 SEA FILE=HCAPLUS ABB=ON L7 OR L9  
L14 1 SEA FILE=HCAPLUS ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR  
FIRST OR 1ST) (3A) (MASK? OR HARDMASK?)  
L15 1 SEA FILE=HCAPLUS ABB=ON L14 OR L10

=> D L15 ALL

L15 ANSWER 1 OF 1 HCAPLUS COPYRIGHT 2005 ACS on STN

AN 2005:493262 HCAPLUS

DN 143:17787

ED Entered STN: 10 Jun 2005

TI Pull-back method of forming fins in  
FinFETs

IN Beintner, Jochen C.; Chidambarrao, Dureseti; Li, Yujun; Settlemyer,  
Kenneth T.

PA International Business Machines Corporation, USA

SO U.S. Pat. Appl. Publ., 15 pp.

CODEN: USXXCO

DT Patent

LA English

IC ICM B44C001-22

ICS C25F003-00

INCL 216011000

CC 76-2 (Electric Phenomena)

Section cross-reference(s): 72, 78

*applicant*

## FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	US 2005121412	A1	20050609	US 2003-730234	20031209
	JP 2005175480	A2	20050630	JP 2004-353535	20041207
PRAI	US 2003-730234	A	20031209		

## CLASS

PATENT NO.	CLASS	PATENT FAMILY CLASSIFICATION CODES
US 2005121412	ICM	B44C001-22
	ICS	C25F003-00
	INCL	216011000
US 2005121412	NCL	216/011.000
JP 2005175480	FTERM	5F110/AA07; 5F110/AA30; 5F110/DD05; 5F110/DD13; 5F110/EE01; 5F110/EE08; 5F110/EE22; 5F110/EE27; 5F110/GG02; 5F110/GG12; 5F110/GG22; 5F110/QQ11; 5F110/QQ19; 5F140/AA00; 5F140/AA29; 5F140/AA39; 5F140/AC36; 5F140/BB03; 5F140/BC15; 5F140/BF01; 5F140/BF04; 5F140/BF10; 5F140/BF44

AB A method of forming integrated circuits having **FinFET** transistors includes a method of forming sub-lithog. **fins**, in which a mask defining a block of silicon including a pair of **fins** in reduced in width or **pulled back** by the thickness of one **fin** on each side, after which a **second mask** is formed around the **first mask**, so that after the **first mask** is removed, an aperture remains in the **second mask** having the width of the separation distance between the pair of **fins**. When the silicon is etched through the aperture, the **fins** are protected by the **second mask**, thereby defining **fin** thickness by the **pullback** step. An alternative method uses lithog. of opposite polarity, first defining the central etch aperture between the two **fins** lithog., then expanding the width of the aperture by a **pullback** step, so that filling the widened aperture with an etch-resistant plug defines the outer edges of the pair of **fins**, thereby setting the **fin** width without an alignment kstep.

ST field effect transistor **fins** silicon masking etching

IT Coating materials  
(masking; **pull-back** method of forming **fins** in **finFET** using)

IT Field effect transistors  
Lithography  
(**pull-back** method of forming **fins** in **finFET**)

IT Etching  
(**pull-back** method of forming **fins** in **finFET** using)

IT Integrated circuits  
(**pull-back** method of forming **fins** in **finFETs**)

IT 7440-21-3, Silicon, processes  
RL: CPS (Chemical process); DEV (Device component use); PEP (Physical, engineering or chemical process); RCT (Reactant); PROC (Process); RACT (Reactant or reagent); USES (Uses)  
(**pull-back** method of forming **fins** in **finFET** using)

IT 12033-89-5P, Silicon Nitride, processes  
RL: CPS (Chemical process); PEP (Physical, engineering or chemical process); PNU (Preparation, unclassified); PREP (Preparation); PROC (Process)

(pull-back method of forming fins in  
finFET using mask from)

IT 7631-86-9P, Silica, processes.

RL: CPS (Chemical process); PEP (Physical, engineering or chemical  
process); PNU (Preparation, unclassified); RCT (Reactant); PREP  
(Preparation); PROC (Process); RACT (Reactant or reagent)

(pull-back method of forming fins in  
finFET using mask from nitride on)

=> FILE WPIX

FILE 'WPIX' ENTERED AT 16:52:00 ON 09 SEP 2005

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FILE LAST UPDATED: 7 SEP 2005 <20050907/UP>

MOST RECENT DERWENT UPDATE: 200557 <200557/DW>

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=>

=> D QUE L13

L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#

L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)

L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)

L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR  
PULLBACK?)

L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)

L11 1 SEA FILE=WPIX ABB=ON L7 OR L9

L12 1 SEA FILE=WPIX ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR FIRST  
OR 1ST) (3A) (MASK? OR HARDMASK?)

L13 1 SEA FILE=WPIX ABB=ON L11 OR L12

=> D FULL L13

L13 ANSWER 1 OF 1 WPIX COPYRIGHT 2005 THE THOMSON CORP on STN

AN 2005-455797 [46] WPIX

DNN N2005-370399 DNC C2005-138706

TI Formation of **fin**s extending from substrate for FET comprises reducing transverse dimensions of **first hardmask** above **fin** block and removing **first hardmask** leaving etch aperture in **second hardmask** having width equal to **fin** separation distance.

DC L03 P78 U11 U12

IN BEINTNER, J C; CHIDAMBARRAO, D; LI, Y; SETTLEMYER, K T

PA (IBMC) IBM CORP; (IBMC) INT BUSINESS MACHINES CORP

CYC 2

PI US 2005121412 A1 20050609 (200546)\* 15 B44C001-22

JP 2005175480 A 20050630 (200546) 17 H01L029-786

ADT US 2005121412 A1 US 2003-730234 20031209; JP 2005175480 A JP 2004-353535 20041207

PRAI US 2003-730234 20031209

IC ICM B44C001-22; H01L029-786

ICS C25F003-00; H01L021-336; H01L029-78

AB US2005121412 A UPAB: 20050720

NOVELTY - Forming **fin(s)** extending from a substrate comprises depositing **first hardmask** on **fin** layer; patterning **fin** layer to form **fin** block(s); reducing the transverse dimensions of **first hardmask** above **fin** block(s) by an amount greater than or equal to the thickness of two **fin**s; forming a **second hardmask**; and removing **first hardmask**, leaving etch aperture(s) in **second hardmask** having a width equal to a **fin** separation distance.

DETAILED DESCRIPTION - Forming **fin(s)** extending from a substrate comprises providing a **fin** layer (50) of semiconductor on the substrate (10); depositing a **first hardmask** on the **fin** layer; patterning the **fin** layer to form **fin** block(s); reducing the transverse dimensions of the **first hardmask** above the **fin** block(s) by an amount greater than or equal to the thickness of two **fin**s; forming a **second hardmask** about and adjacent to the **first hardmask**; removing the **first hardmask**, leaving etch aperture(s) in the **second hardmask** having a width equal to a **fin** separation distance between adjacent **fin**s; and etching the **fin** layer through the aperture(s) to form the **fin(s)**.

USE - For forming **fin(s)** extending from a substrate for forming integrated circuits having double gate field effect transistors (**FinFET**).

ADVANTAGE - The vertical silicon slices that contain the transistor body (**fin**s) are defined in a self-aligned fashion relative to a block of silicon so that the **fin** width does not depend on tolerances in alignment but on a material removal process.

DESCRIPTION OF DRAWING(S) - The figure shows silicon blocks after a **pull-back** operation that reduces the width of the **hardmask**.

Substrate 10

Buried oxide insulator layer 20

**Fin** layer 50

Layer of oxide 52

Thinner dimension 53

Layer of nitride 54

Dwg.2/12

TECH US 2005121412 A1UPTX: 20050720

TECHNOLOGY FOCUS - CERAMICS AND GLASS - Preferred Materials: The **first hardmask** comprises a layer of nitride (54) above a

layer of oxide (52). The **fin** layer comprises silicon.

TECHNOLOGY FOCUS - MECHANICAL ENGINEERING - Preferred Method: The step of reducing comprises etching vertical sides of the **first hardmask** with a wet etch. An aperture extending over one side of a **fin** block of a set of **fin** blocks is lithographically defined after forming the **second hardmask** and before removing the **first hardmask**. A blocking mask is lithographically defined over an end portion of the set of **fin** blocks to prevent the end portion of the set of **fin** blocks from being separated.

TECHNOLOGY FOCUS - ORGANIC CHEMISTRY - Preferred Materials: The wet etch is a mixture of hydrogen fluoride (HF) and ethylene glycol (EG).

FS CPI EPI GMPI  
FA AB; GI  
MC CPI: L04-C06A; L04-E01A  
EPI: U11-C05E3; U11-C05F1; U12-D02A9; U12-E02

=> FILE INSPEC

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=> D QUE L16

L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#  
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)  
L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR  
PULLBACK?)  
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L10 1 SEA FILE=HCAPLUS ABB=ON L7 OR L9  
L14 1 SEA FILE=HCAPLUS ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR  
FIRST OR 1ST) (3A) (MASK? OR HARDMASK?)  
L16 0 SEA FILE=INSPEC ABB=ON L14 OR L10

=> FILE COMPENDEX

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<<< SOME LITTLE CHANGES IN TEXT OF CLASSIFICATION AS OF JUNE 13, 2005  
SEE HELP CLA >>>



=> D QUE L17

L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#  
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)  
L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR  
PULLBACK?)  
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L10 1 SEA FILE=HCAPLUS ABB=ON L7 OR L9  
L14 1 SEA FILE=HCAPLUS ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR  
FIRST OR 1ST) (3A) (MASK? OR HARDMASK?)  
L17 0 SEA FILE=COMPENDEX ABB=ON L14 OR L10

=> FILE NTIS

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=> D QUE L18

L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#  
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)  
L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR  
PULLBACK?)  
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO) (3A) (MASK  
? OR HARDMASK?)  
L10 1 SEA FILE=HCAPLUS ABB=ON L7 OR L9  
L14 1 SEA FILE=HCAPLUS ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR  
FIRST OR 1ST) (3A) (MASK? OR HARDMASK?)  
L18 0 SEA FILE=NTIS ABB=ON L14 OR L10

=> FILE JICST

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L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#  
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)  
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? OR HARDMASK?)  
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR  
PULLBACK?)  
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO) (3A) (MASK

? OR HARDMASK?)  
L10 1 SEA FILE=HCAPLUS ABB=ON L7 OR L9  
L14 1 SEA FILE=HCAPLUS ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR  
FIRST OR 1ST) (3A) (MASK? OR HARDMASK?)  
L19 0 SEA FILE=JICST-EPLUS ABB=ON L14 OR L10

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=> D QUE L20

L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#  
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)  
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? OR HARDMASK?)  
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L20 0 SEA FILE=JAPIO ABB=ON L14 OR L10

=> FILE EPFUL

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=> HELP CHANGE (last updated January 11, 2005). <<<

>>> File enhanced with backlog data

At June 06, 20, 21, 24, and 27, and July 18, 2005 bibliographies  
for A-documents between 1978 and 1997 have been added to the  
EPFULL file. Please consider this in your search strategy.  
See HELP CURRENT for details. <<<

=> D QUE L26

L22 94 SEA FILE=EPFULL ABB=ON (FINS OR FIN OR FINFET?) (P) (PULL?(W)BAC  
K? OR PULLBACK?)  
L24 0 SEA FILE=EPFULL ABB=ON L22 (P) (2ND OR SECOND OR TWO) (3A) (MASK?  
OR HARDMASK?)  
L25 0 SEA FILE=EPFULL ABB=ON L22 (P) (MANY OR MULTI? OR FIRST OR  
1ST) (3A) (MASK? OR HARDMASK?)  
L26 0 SEA FILE=EPFULL ABB=ON L24 OR L25